

CLAIMS

What is claimed is:

1. A method for estimating an amount of drawn air of a cylinder of an internal combustion engine, comprising the steps of:

obtaining an estimated value of an amount of drawn air of the cylinder, based on a value of intake manifold pressure;

determining a value of an identification parameter using an adaptive observer in such a way that a product of the estimated value of an amount of drawn air of the cylinder, based on a value of intake manifold pressure and a value of the identification parameter, is made equal to a value of an amount of air having passed through the throttle; and

multiplying the estimated value of an amount of drawn air of the cylinder, based on a value of intake manifold pressure, by the value of the identification parameter to obtain a final estimated value of an amount of drawn air of the cylinder.

2. A method for estimating an amount of drawn air of a cylinder according to claim 1, wherein in the step of determining an identification parameter using an adaptive observer, an amount of lift of an exhaust gas recycling valve is further used for identification.

3. A method for estimating an amount of drawn air of a cylinder of an internal combustion engine, comprising the steps of:

obtaining an estimated value of an amount of drawn air of the cylinder, based on a value of intake manifold pressure;

obtaining an estimated value of an amount of recycled exhaust gas based on a value of intake manifold pressure, a value corresponding to pressure inside an exhaust manifold and a value of an amount of lift of an exhaust gas recycling valve;

determining values of first and second identification parameters using an adaptive observer in such a way that a value obtained by subtracting a product of the

estimated value of an amount of recycled exhaust gas and a value of the second identification parameter, from a product of the estimated value of an amount of drawn air of the cylinder, based on a value of intake manifold pressure and a value of the first identification parameter, is made equal to a value of an amount of air having passed through the throttle; and

subtracting a product of the estimated value of an amount of recycled exhaust gas and the value of the second identification parameter, from a product of the estimated value of an amount of drawn air of the cylinder, based on a value of intake manifold pressure and the value of the first identification parameter, to obtain a final estimated value of an amount of drawn air of the cylinder.

4. A method for estimating an amount of drawn air of a cylinder according to claim 3, wherein in the step of determining first and second identification parameters using an adaptive observer, a forgetting factor is used for the second identification parameter.

5. A method for estimating an amount of drawn air of a cylinder of an internal combustion engine, comprising the steps of:

obtaining an estimated value of an amount of drawn air of the cylinder, based on a value of intake manifold pressure;

obtaining a difference of values of intake manifold pressure, a second-order difference of values of intake manifold pressure, a difference of values of an amount of air having passed through a throttle and a difference of estimated values of an amount of drawn air of the cylinder, based on a value of intake manifold pressure;

determining a value of an identification parameter using an adaptive observer in such a way that a product of the second-order difference of values of intake manifold pressure and a value of the identification parameter, made equal to a value obtained by subtracting the difference of estimated values of an amount of drawn air of the cylinder, based on a value of intake manifold pressure, from the difference of values of an amount of air having passed through the throttle; and

subtracting a product of the difference of values of intake manifold pressure

and the value of the identification parameter, from a value of an amount of air having passed through the throttle, to obtain a final estimated value of an amount of drawn air of the cylinder.

6. A method for controlling an amount of drawn air of a cylinder of an internal combustion engine, wherein the final estimated value of an amount of drawn air of the cylinder, obtained through a method for estimating an amount of drawn air of the cylinder, according to claim 1, is controlled to a desired value.

7. A method for controlling an amount of drawn air of a cylinder, according to claim 6, wherein a response-specifying type control algorithm is employed.

8. An apparatus for estimating an amount of drawn air of a cylinder of an internal combustion engine, comprising:

- a module for obtaining an estimated value of an amount of drawn air of the cylinder, based on a value of intake manifold pressure to deliver the estimated value as an output;

- a module for determining a value of an identification parameter using an adaptive observer, based on the estimated value of an amount of drawn air of the cylinder, based on a value of intake manifold pressure and an amount of air having passed through a throttle, in such a way that a product of the estimated value and a value of the identification parameter, is made equal to a value of an amount of air having passed through the throttle, to deliver a value of the identification parameter as an output; and

- a multiplying module for multiplying the estimated value, by the value of identification parameter to obtain a final estimated value of an amount of drawn air of the cylinder.

9. An apparatus for estimating an amount of drawn air of a cylinder according to claim 8, wherein the module for determining an identification parameter using an adaptive

observer to deliver the identification parameter as an output, further receives as an input an amount of lift of a exhaust gas recycling valve and uses the amount for identification.

10. An apparatus for estimating an amount of drawn air of a cylinder of an internal combustion engine, comprising:

- a module for obtaining an estimated value of an amount of drawn air of the cylinder, based on a value of intake manifold pressure, to deliver the estimated value of an amount of drawn air, as an output;

- a module for obtaining an estimated value of an amount of recycled exhaust gas based on a value of intake manifold pressure, a value corresponding to pressure inside an exhaust manifold and a value of an amount of lift of an exhaust gas recycling valve, to deliver the estimated value of an amount of recycled exhaust gas, as an output;

- a module for determining first and second identification parameters using an adaptive observer in such a way that a value obtained by subtracting a product of the estimated value of an amount of recycled exhaust gas and a value of the second identification parameter, from a product of the estimated value of an amount of drawn air of the cylinder, based on a value of intake manifold pressure and a value of the first identification parameter, is made equal to a value of an amount of air having passed through the throttle, to deliver values of the first and second identification parameters as outputs; and

- a module for subtracting a product of the estimated value of an amount of recycled exhaust gas and the value of the second identification parameter, from a product of the estimated value of an amount of drawn air of the cylinder, based on a value of intake manifold pressure and the value of the first identification parameter, to obtain and deliver, as an output, a final estimated value of an amount of drawn air of the cylinder.

11. An apparatus for estimating an amount of drawn air of a cylinder according to

claim 10, wherein in the module for determining first and second identification parameters to deliver the first and second identification parameters, as outputs, a forgetting factor is used for the second identification parameter.

12. An apparatus for estimating an amount of drawn air of a cylinder of an internal combustion engine, comprising:

- a module for obtaining an estimated value of an amount of drawn air of the cylinder, based on a value of intake manifold pressure, to deliver the estimated value of an amount of drawn air, as an output;

- at least one module for obtaining a difference of values of intake manifold pressure, a second-order difference of values of intake manifold pressure, a difference of values of an amount of air having passed through a throttle and a difference of estimated values of an amount of drawn air of the cylinder, based on a value of intake manifold pressure;

- a module for determining a value of an identification parameter using an adaptive observer in such a way that a product of the second-order difference of values of intake manifold pressure and a value of the identification parameter, is made equal to a value obtained by subtracting the difference of estimated values of an amount of drawn air of the cylinder, based on a value of intake manifold pressure, from the difference of values of an amount of air having passed through the throttle;

- a module for multiplying the difference of values of intake manifold pressure by the value of the identification parameter; and

- a module for subtracting a product of the difference of values of intake manifold pressure and the value of the identification parameter, from a value of an amount of air having passed through the throttle, to obtain and deliver, as an output, a final estimated value of an amount of drawn air of the cylinder.

13. An apparatus for controlling an amount of drawn air of a cylinder, comprising:

- an apparatus for estimating an amount of drawn air of a cylinder according to claim 8; and

a controller receiving, as inputs, the final estimated value of the apparatus for estimating an amount of drawn air of a cylinder and a desired value of an amount of drawn air, to manipulate throttle opening in such a way that the final estimated value is controlled at the desired value.

14. An apparatus for controlling an amount of drawn air of a cylinder, according to claim 13, wherein the controller employs a response-specifying type control algorithm.

15. A computer-readable medium having a program stored therein, the program is made to perform the steps of:

obtaining an estimated value of an amount of drawn air of the cylinder, based on a value of intake manifold pressure;

determining a value of an identification parameter using an adaptive observer in such a way that a product of the estimated value of an amount of drawn air of the cylinder, based on a value of intake manifold pressure and a value of the identification parameter, is made equal to a value of an amount of air having passed through the throttle; and

multiplying the estimated value of an amount of drawn air of the cylinder, based on a value of intake manifold pressure, by a value of identification parameter to obtain a final estimated value of an amount of drawn air of the cylinder.

16. A computer-readable medium according to claim 15, wherein in the step of determining an identification parameter using an adaptive observer, an amount of lift of an exhaust gas recycling valve is further used for identification.

17. A computer-readable medium having a program stored therein, the program is made to perform the steps of:

obtaining an estimated value of an amount of drawn air of the cylinder, based on a value of intake manifold pressure;

obtaining an estimated value of an amount of recycled exhaust gas based on a

value of intake manifold pressure, a value corresponding to pressure inside an exhaust manifold and a value of an amount of lift of an exhaust gas recycling valve;

determining first and second identification parameters using an adaptive observer in such a way that a value obtained by subtracting a product of the estimated value of an amount of recycled exhaust gas and a value of the second identification parameter, from a product of the estimated value of an amount of drawn air of the cylinder, based on a value of intake manifold pressure and a value of the first identification parameter, is made equal to a value of an amount of air having passed through the throttle; and

subtracting a product of the estimated value of an amount of recycled exhaust gas and a value of the second identification parameter, from a product of the estimated value of an amount of drawn air of the cylinder, based on a value of intake manifold pressure and a value of the first identification parameter, to obtain a final estimated value of an amount of drawn air of the cylinder.

18. A computer-readable medium according to claim 17, wherein in the step of determining first and second identification parameters using an adaptive observer, a forgetting factor is used for the second identification parameter.

19. A computer-readable medium having a program stored therein, the program is made to perform the steps of:

obtaining an estimated value of an amount of drawn air of the cylinder, based on a value of intake manifold pressure;

obtaining a difference of values of intake manifold pressure, a second-order difference of values of intake manifold pressure, a difference of values of an amount of air having passed through a throttle and a difference of estimated values of an amount of drawn air of the cylinder, based on a value of intake manifold pressure;

determining a value of an identification parameter using an adaptive observer in such a way that a product of the second-order difference of values of intake manifold pressure and a value of the identification parameter, made equal to a value obtained

by subtracting the difference of estimated values of an amount of drawn air of the cylinder, based on a value of intake manifold pressure, from the difference of values of an amount of air having passed through the throttle; and

subtracting a product of the difference of values of intake manifold pressure and the value of the identification parameter, from a value of an amount of air having passed through the throttle, to obtain a final estimated value of an amount of drawn air of the cylinder.

20. A computer-readable medium according to claim 15, wherein the program is further made to perform the step of controlling the final estimated value of an amount of drawn air of the cylinder, to a desired value.

21. A computer-readable medium according to claim 20, wherein in the program a response-specifying type control algorithm is employed.

22. An apparatus for estimating an amount of drawn air of a cylinder of an internal combustion engine, comprising:

means for obtaining an estimated value of an amount of drawn air of the cylinder, based on a value of intake manifold pressure to deliver the estimated value as an output;

means for determining a value of an identification parameter using an adaptive observer, based on the estimated value of an amount of drawn air of the cylinder, based on a value of intake manifold pressure and an amount of air having passed through a throttle, in such a way that a product of the estimated value and a value of the identification parameter, is made equal to a value of an amount of air having passed through the throttle, to deliver a value of the identification parameter as an output; and

means for multiplying the estimated value, by the value of identification parameter to obtain a final estimated value of an amount of drawn air of the cylinder.

23. An apparatus for estimating an amount of drawn air of a cylinder according to claim 22, wherein the means for determining an identification parameter using an adaptive observer to deliver the identification parameter as an output, further receives as an input an amount of lift of a exhaust gas recycling valve and uses the amount for identification.

24. An apparatus for estimating an amount of drawn air of a cylinder of an internal combustion engine, comprising:

means for obtaining an estimated value of an amount of drawn air of the cylinder, based on a value of intake manifold pressure, to deliver the estimated value of an amount of drawn air, as an output;

means for obtaining an estimated value of an amount of recycled exhaust gas based on a value of intake manifold pressure, a value corresponding to pressure inside an exhaust manifold and a value of an amount of lift of an exhaust gas recycling valve, to deliver the estimated value of an amount of recycled exhaust gas, as an output;

means for determining first and second identification parameters using an adaptive observer in such a way that a value obtained by subtracting a product of the estimated value of an amount of recycled exhaust gas and a value of the second identification parameter, from a product of the estimated value of an amount of drawn air of the cylinder, based on a value of intake manifold pressure and a value of the first identification parameter, is made equal to a value of an amount of air having passed through the throttle, to deliver values of the first and second identification parameters as outputs; and

means for subtracting a product of the estimated value of an amount of recycled exhaust gas and the value of the second identification parameter, from a product of the estimated value of an amount of drawn air of the cylinder, based on a value of intake manifold pressure and the value of the first identification parameter, to obtain and deliver, as an output, a final estimated value of an amount of drawn air of the cylinder.

25. An apparatus for estimating an amount of drawn air of a cylinder according to claim 24, wherein in the means for determining first and second identification parameters to deliver the first and second identification parameters, as outputs, a forgetting factor is used for the second identification parameter.

26. An apparatus for estimating an amount of drawn air of a cylinder of an internal combustion engine, comprising:

means for obtaining an estimated value of an amount of drawn air of the cylinder, based on a value of intake manifold pressure, to deliver the estimated value of an amount of drawn air, as an output;

at least one means for obtaining a difference of values of intake manifold pressure, a second-order difference of values of intake manifold pressure, a difference of values of an amount of air having passed through a throttle and a difference of estimated values of an amount of drawn air of the cylinder, based on a value of intake manifold pressure;

means for determining a value of an identification parameter using an adaptive observer in such a way that a product of the second-order difference of values of intake manifold pressure and a value of the identification parameter, is made equal to a value obtained by subtracting the difference of estimated values of an amount of drawn air of the cylinder, based on a value of intake manifold pressure, from the difference of values of an amount of air having passed through the throttle;

means for multiplying the difference of values of intake manifold pressure by the value of the identification parameter; and

means for subtracting a product of the difference of values of intake manifold pressure and the value of the identification parameter, from a value of an amount of air having passed through the throttle, to obtain and deliver, as an output, a final estimated value of an amount of drawn air of the cylinder.

27. An apparatus for controlling an amount of drawn air of a cylinder, comprising:

an apparatus for estimating an amount of drawn air of a cylinder according to

claim 8; and

means for controlling an amount of drawn air, receiving, as inputs, the final estimated value of the apparatus for estimating an amount of drawn air of a cylinder and a desired value of an amount of drawn air, to manipulate throttle opening in such a way that the final estimated value is controlled at the desired value.

28. An apparatus for controlling an amount of drawn air of a cylinder, according to claim 27, wherein the controlling means employs a response-specifying type control algorithm.